

AMENDMENTSIn the Claims

Please cancel claims 2-8, 12, 42-48, and 52 without prejudice.

Please amend claims 1, 9, 17, 34, 41, 49, 57, 74, and 76 as shown herein.

Claims 1, 9-11, 13-41, 49-51, and 53-80 are pending as follows:

1. **(currently amended)** A method for use in a wireless communication system, the method comprising:

outputting at least one signal suitable for causing a smart antenna to transmit at least one complementary beam, said at least one signal being operatively configured to cause said smart antenna to perform single beam complementary beamforming (SBCBF);

causing said smart antenna to transmit said at least one complementary beam based on said at least one signal; and

configuring said at least one signal to cause said smart antenna to perform said SBCBF by transmitting energy at a detectable transmit power level in all smart antenna-supported directions while substantially preserving a shape of at least one main transmit beam having a transmit power level that is significantly greater than said detectable transmit power level, said SBCBF being operatively performed by said smart antenna that is operatively associated with a base station within a wireless communication system, said base station including a Butler matrix network configured to form said at least one main beam using said smart antenna, and further configured to provide at least one of post-combining SBCBF or pre-combining SBCBF.

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2 2-8. (canceled)  
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4 9. (currently amended) ~~The method as recited in Claim 1,~~  
5 ~~wherein A method for use in a wireless communication system, the method~~  
6 ~~comprising:~~  
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8 outputting at least one signal suitable for causing a smart antenna to  
9 transmit at least one complementary beam, said at least one signal is being  
10 operatively configured to cause said smart antenna to perform subspace  
11 complementary beamforming (SCBF), and said at least one signal including N-K  
12 data streams operatively configured to cause said smart antenna to transmit energy  
13 in at least one side lobe.

14 10. (original) The method as recited in Claim 9, further comprising:  
15 determining said at least one signal by selectively modifying a weight  
16 matrix to operatively support said SCBF.  
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18 11. (original) The method as recited in Claim 9, further comprising:  
19 determining said at least one signal by selectively expanding a size of a  
20 weight matrix to operatively support said SCBF.  
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22 12. (canceled)  
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1           13. (original) The method as recited in Claim 9, further comprising:  
 2           determining said at least one signal by using a Downlink Beamforming  
 3           Matrix:  $W = U\Lambda V^H$ .

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 5           14. (original) The method as recited in Claim 9, further comprising:  
 6           determining said at least one signal by using a Steering Matrix:  
 7            $A = [a(\theta_1) \ a(\theta_2) \ \dots \ a(\theta_K)]$ , wherein  $a(\theta_k)$  represents a steering vector of user k.

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 9           15. (original) The method as recited in Claim 14, wherein:  
 10          if  $W = A^*B$ , where  $B$  is a non-singular  $K$ -by- $K$  matrix, then using a  
 11          complementary beamforming matrix of

$$12 \quad W^c = \sqrt{\frac{k_0 C_0}{N}} [u_{K+1} \ u_{K+2} \ \dots \ u_N]$$

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 14          wherein  $C_0 = Nc_0$  is the level of the main lobe,  $k_0$  is the scaling factor and  
 15           $u_l$  is the  $l$ -th column vector of  $U$ ,

16          otherwise using a complementary beamforming matrix of

$$17 \quad W^c = \sqrt{\frac{k_0 C_0}{N}} [\bar{u}_1 \ \bar{u}_2 \ \dots \ \bar{u}_{N-K}]$$

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 19          wherein  $\bar{u}_l$  is the  $l$ -th left singular vector of the matrix  
 20           $\left( \sum_{l=K+1}^N \tilde{u}_l \tilde{u}_l^H \right) U\Lambda^c = \bar{U}\bar{\Lambda}\bar{V}^H$ , and  $A^* = \bar{U}\bar{\Lambda}\bar{V}^H$  is assumed, and in scattering  
 21          channel  $H^* = \tilde{U}\tilde{\Lambda}\tilde{V}^H$  is assumed.

1       **16. (original)** The method as recited in Claim 15, wherein it is  
 2       assumed that  $2K < N$ ,

3        $W_a = [W \quad A^*] = U_a A_a V_a^H$ , and  $W^c = \sqrt{\frac{k_0 C_0}{N}} [u_{a,r+1} \quad u_{a,r+2} \quad \cdots \quad u_{a,N}]$ ,

4       and wherein  $r$  is rank of  $W_a$ .

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7       **17. (currently amended)** The method as recited in Claim 1,  
 8       wherein A method for use in a wireless communication system, the method  
 9       comprising:

10       outputting at least one signal suitable for causing a smart antenna to  
 11       transmit at least one complementary beam, said at least one signal is being  
 12       operatively configured to cause said smart antenna to perform complementary  
 13       superposition beamforming (CSBF).

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15       **18. (original)** The method as recited in Claim 17, further comprising:  
 16       determining said at least one signal by using a downlink beamforming  
 17       matrix:  $\tilde{W} = [w_1 \quad \cdots \quad w_{k-1} \quad \tilde{w}_k \quad w_{k+1} \quad \cdots \quad w_K]$ , where  $\tilde{w}_k = p_0 w_k + W^c p$  and  $p$  is  
 18       complex conjugate transpose of the  $l$ -th row of  $W^c$ ,  $p_0 = \frac{w_{k,l}}{|w_{k,l}|}$  is normalized  
 19       complex conjugate of the  $l$ -th element of  $w_k$ .

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21       **19. (original)** The method as recited in Claim 18, wherein  $W^c$  is  
 22       associated with subspace complementary beamforming (SCBF).

1       **20. (original)** The method as recited in Claim 17, further comprising:  
2       determining said at least one signal by using  $\tilde{W} = [w_1 \ w_2 \ \dots \ w_k \ W^c p]$ .

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4       **21. (original)** The method as recited in Claim 17, further comprising:  
5       determining said at least one signal by using a null-generation technique  
6       that is configured to generate  $L$  nulls at angles  $\theta_1, \theta_2, \dots, \theta_L$  at a beam.

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8       **22. (original)** The method as recited in Claim 17, further comprising:  
9       determining said at least one signal by using  $A = [a(\theta_1) \ a(\theta_2) \ \dots \ a(\theta_L)]$ .

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11      **23. (original)** The method as recited in Claim 17, further comprising:  
12      determining said at least one signal by projecting  $w$  onto orthogonal  
13      complement subspace of column space  $A^*$ .

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15      **24. (original)** The method as recited in Claim 17, further comprising:  
16      determining said at least one signal by using a vector:  $w = (I - P_s)w$  where  
17       $P_s = A^*(A^T A^*)^{-1} A^T$ , and in scattering channel  $P_s = H^*(H^T H^*)^{-1} H^T$ .

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19      **25. (original)** The method as recited in Claim 17, further comprising:  
20      determining said at least one signal by using a null-widening technique that  
21      is configured to produce at least one null at a vicinity of selected angles.

1           26. (original) The method as recited in Claim 17, further comprising:  
2           determining said at least one signal by selectively modifying a steering  
3 matrix to:  $A = [\tilde{a}(\theta_1) \quad \tilde{a}(\theta_2) \quad \dots \quad \tilde{a}(\theta_K)]$   
4           wherein  $\tilde{a}(\theta_k) = [a(\theta_k - \Delta\theta_r) \quad a(\theta_k) \quad a(\theta_k + \Delta\theta_r)]$ .

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6           27. (original) The method as recited in Claim 17, further comprising:  
7           determining said at least one signal by establishing at least two nulls such  
8 that a rank of  $A$  is less than  $N$ .

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10          28. (original) The method as recited in Claim 17, further comprising:  
11          determining said at least one signal by using adaptive control of a  
12 complementary beam level.

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14          29. (original) The method as recited in Claim 17, further comprising:  
15          determining said at least one signal by, in a non-zero angular channel,  
16 selectively reducing a complementary beam level.

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18          30. (original) The method as recited in Claim 17, further comprising:  
19          determining said at least one signal by, for delay spread channels,  
20 selectively reducing a complementary beam level.

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22          31. (original) The method as recited in Claim 17, further comprising:  
23          determining said at least one signal by, in free space, selectively increasing  
24 the complementary beam level.

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2       **32. (original)** The method as recited in Claim 1, wherein outputting  
3 said at least one signal suitable for causing said smart antenna to transmit at least  
4 one complementary beam further includes:  
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6              using a zero-forcing beamformer to output said at least one signal.  
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8       **33. (original)** The method as recited in Claim 1, wherein outputting  
9 said at least one signal suitable for causing said smart antenna to transmit at least  
one complementary beam further includes:  
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11              using a maximum SINR beamformer to output said at least one signal.  
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lee@hayes

1           **34. (currently amended)** The method as recited in Claim 1,  
2        ~~wherein outputting said at least one signal suitable for causing said smart antenna~~  
3        ~~to transmit at least one complementary beam further includes:~~

4           A method for use in a wireless communication system, the method  
5        comprising:

6           outputting at least one signal suitable for causing a smart antenna to  
7        transmit at least one complementary beam, wherein said outputting includes  
8        selectively constructing a plurality of matrices  $Z_1, Z_2, \dots, Z_L$ , where  $L$  is a length of  
9        a downlink transmission period, such that said plurality of matrices satisfy at least  
10      one property selected from a group of properties comprising:

- 11        (a) for all  $1 \leq i \leq L$ , a matrix  $Z_i$  is a  $k \times m$  matrix whose rows are in a set  
12         $\{0, \pm U_0^H, \pm U_1^H, \dots, \pm U_{m-k-1}^H\}$ ;
- 13        (b) if  $L$  is even, then,  $Z_2 = -Z_1, Z_4 = -Z_3, \dots, Z_L = -Z_{L-1}$ ;
- 14        (c) if  $L$  is odd, then  $Z_2 = -Z_1, Z_4 = -Z_3, \dots, Z_{L-1} = -Z_{L-2}, Z_L = 0$ ; and
- 15        (d) each element  $+U_0^H, -U_0^H, +U_1^H, -U_1^H, \dots, +U_{m-k-1}^H, -U_{m-k-1}^H$  appear  $p$   
16      times in a list of  $Lk$  rows of  $Z_1, Z_2, \dots, Z_L$  for some positive integer  $p$ .

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18        **35. (original)** The method as recited in Claim 34, wherein rows of  
19       $Z_{2i-1}$  are, respectively,  $U_{0\oplus i}^H, U_{1\oplus i}^H, \dots, U_{k-1\oplus i}^H$  and where  $i\oplus j$  denote  $(i + j)$   
20      mod  $(m-k)$  for  $i = 1, 2, 3, \dots, [L/2]$  and wherein  $Z_{2i} = -Z_{2i-1}$ .

1           **36. (original)** The method as recited in Claim 34, further comprising:  
 2           using as a beamforming matrix:

$$3 \quad S' = \left[ (A^H A)^{-1} A^H / \sqrt{\text{Tr}((A^H A)^{-1})} + \frac{1}{\sqrt{k}} \varepsilon Z_i \right]$$

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 5           where  $\varepsilon \geq 0$  is a fixed positive number.

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 7           **37. (original)** The method as recited in Claim 36, wherein said  
 8           complementary beam is configured to cause a loss of at most  $10 \log_{10}(1+|\varepsilon|^2)$  in a  
 9           received signal for an intended recipient.

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 11          **38. (original)** The method as recited in Claim 36, wherein said  
 12          complementary beam is configured to direct a portion:

$$13 \quad |\varepsilon|^2 \frac{\sum_{j=1}^m |b_j|^2}{m}$$

14  
 15          of a resulting transmitted power to another recipient whose spatial signature  
 16          is  $B = (b_1, b_2, \dots, b_m)$ .

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 18          **39. (original)** The method as recited in Claim 1, wherein outputting  
 19          said at least one signal suitable for causing said smart antenna to transmit at least  
 20          one complementary beam further includes:

21          outputting said signal based on at least a complementary beamforming  
 22          matrix at time  $t$  given by:

$$23 \quad S' = \left[ (A^H A)^{-1} A^H / \sqrt{\text{Tr}((A^H A)^{-1})} + \frac{1}{\sqrt{k}} \varepsilon Z_i \right]$$

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2       **40. (original)** The method as recited in Claim 1, wherein outputting  
3 said at least one signal suitable for causing said smart antenna to transmit at least  
4 one complementary beam further includes:

5           outputting said signal based on at least matrices  $P_0, P_1, \dots, P_{m-k}$  having rows,  
6 respectively,  $U_0^H, U_1^H, \dots, U_{m-k}^H$  and wherein a fixed beamforming matrix is given by:

7           
$$S = \left[ (A^H A)^{-1} A^H / \sqrt{\text{Tr}\left((A^H A)^{-1}\right)} + \frac{1}{\sqrt{k}} \varepsilon \sum_{i=1}^{m-k} P_i \right].$$

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1           **41. (currently amended)** An apparatus for use in a wireless  
2 communication system, the apparatus comprising:

3           a smart antenna operatively coupled to receive at least one signal and  
4 configured to transmit at least one complementary beam based on said at least one  
5 signal; and

6           circuitry configured to output said at least one signal suitable for causing  
7 [[a]] the smart antenna to transmit said at least one complementary beam, said at  
8 least one signal being operatively configured to cause said smart antenna to  
9 perform single beam complementary beamforming (SBCBF), said at least one  
10 signal being configured by said circuitry to cause said smart antenna to perform  
11 said SBCBF by transmitting energy at a detectable transmit power level in all  
12 smart antenna-supported directions while substantially preserving a shape of at  
13 least one main transmit beam having a transmit power level that is significantly  
14 greater than said detectable transmit power level, said smart antenna being  
15 operatively associated with a base station within the wireless communication  
16 system, said base station including at least a portion of said circuitry which  
17 includes a Butler matrix network configured to form said at least one main beam  
18 using said smart antenna, and said Butler matrix network being configured to  
19 provide at least one of post-combining SBCBF or pre-combining SBCBF.

20           **42-48. (canceled)**

1           **49. (currently amended)** ~~The apparatus as recited in Claim 41,~~  
2 ~~wherein An apparatus for use in a wireless communication system, the apparatus~~  
3 ~~comprising:~~

4           circuitry configured to output at least one signal suitable for causing a smart  
5 antenna to transmit at least one complementary beam, said at least one signal is  
6 being operatively configured to cause said smart antenna to perform subspace  
7 complementary beamforming (SCBF), and said at least one signal including N-K  
8 data streams operatively configured to cause said smart antenna to transmit energy  
9 in at least one side lobe.

10           **50. (original)** The apparatus as recited in Claim 49, wherein said  
11 circuitry is configured to determine said at least one signal by selectively  
12 modifying a weight matrix to operatively support said SCBF.

14           **51. (original)** The apparatus as recited in Claim 49, wherein said  
15 circuitry is configured to determine said at least one signal by selectively  
16 expanding a size of a weight matrix to operatively support said SCBF.

18           **52. (canceled)**

20           **53. (original)** The apparatus as recited in Claim 49, wherein said  
21 circuitry is configured to determine said at least one signal by using a Downlink  
22 Beamforming Matrix:  $W = U \Lambda V^H$ .

1           **54. (original)** The apparatus as recited in Claim 49, wherein said  
2 circuitry is configured to determine said at least one signal by using a Steering  
3 Matrix:  $A = [a(\theta_1) \ a(\theta_2) \ \dots \ a(\theta_K)]$ , wherein  $a(\theta_k)$  represents a steering vector  
4 of user k.

5           **55. (original)** The apparatus as recited in Claim 54, wherein:  
6 if  $W = A^* B$ , where  $B$  is a non-singular  $K$ -by- $K$  matrix, then said circuitry is  
7 configured to use a complementary beamforming matrix of

$$9 \quad W^c = \sqrt{\frac{k_0 C_0}{N}} [u_{K+1} \ u_{K+2} \ \dots \ u_N]$$

10           wherein  $C_0 = N c_0$  is the level of the main lobe,  $k_0$  is the scaling factor and  
11  $u_l$  is the  $l$ -th column vector of  $U$ ,

12           otherwise said circuitry is configured to use a complementary beamforming  
13 matrix of

$$15 \quad W^c = \sqrt{\frac{k_0 C_0}{N}} [\bar{u}_1 \ \bar{u}_2 \ \dots \ \bar{u}_{N-K}]$$

16           wherein  $\bar{u}_l$  is the  $l$ -th left singular vector of the matrix  
17 
$$\left( \sum_{i=K+1}^N \tilde{u}_i \tilde{u}_i^H \right) U A^c = \bar{U} \bar{\Lambda} \bar{V}^H$$
, and  $A^* = \tilde{U} \tilde{\Lambda} \tilde{V}^H$  is assumed, and in scattering  
18 channel  $H^* = \tilde{U} \tilde{\Lambda} \tilde{V}^H$  is assumed.  
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1           **56. (original)** The apparatus as recited in Claim 55, wherein said  
2 circuitry is configured such that  $2K < N$ ,

3            $W_a = [W \quad A^*] = U_a \Lambda_a V_a^H$ , and  $W^c = \sqrt{\frac{k_0 C_0}{N}} [u_{a,r+1} \quad u_{a,r+2} \quad \cdots \quad u_{a,N}]$ ,

4           and wherein  $r$  is rank of  $W_a$ .

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6           **57. (currently amended)** ~~The apparatus as recited in Claim 41,~~  
7           wherein An apparatus for use in a wireless communication system, the apparatus  
8           comprising:

9           circuitry configured to output at least one signal suitable for causing a smart  
10          antenna to transmit at least one complementary beam, said circuitry is being  
11          configured such that said at least one signal causes said smart antenna to perform  
12          complementary superposition beamforming (CSBF).

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14           **58. (original)** The apparatus as recited in Claim 57, wherein said  
15 circuitry is configured to determine said at least one signal by using a downlink  
16 beamforming matrix:  $\tilde{W} = [w_1 \quad \cdots \quad w_{k-1} \quad \tilde{w}_k \quad w_{k+1} \quad \cdots \quad w_K]$ , where  
17  $\tilde{w}_k = p_0 w_k + W^c p$  and  $p$  is complex conjugate transpose of the  $k$ -th row of  $W^c$ ,  
18  $p_0 = \frac{w_{k,l}^*}{|w_{k,l}|}$  is normalized complex conjugate of the  $k$ -th element of  $w_k$ .

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20           **59. (original)** The apparatus as recited in Claim 58, wherein  $W^c$  is  
21 associated with subspace complementary beamforming (SCBF).

1       **60. (original)** The apparatus as recited in Claim 57, wherein said  
2 circuitry is configured to determine said at least one signal by using  
3  $\tilde{W} = [w_1 \ w_2 \ \cdots \ w_k \ W^c p]$ .

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5       **61. (original)** The apparatus as recited in Claim 57, wherein said  
6 circuitry is configured to determine said at least one signal by using a  
7 null-generation technique that is configured to generate  $L$  nulls at angles  
8  $\theta_1, \theta_2, \dots, \theta_L$  at a beam.

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10      **62. (original)** The apparatus as recited in Claim 57, wherein said  
11 circuitry is configured to determine said at least one signal by using  
12  $A = [a(\theta_1) \ a(\theta_2) \ \cdots \ a(\theta_L)]$ .

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14      **63. (original)** The apparatus as recited in Claim 57, wherein said  
15 circuitry is configured to determine said at least one signal by projecting  $w$  onto  
16 orthogonal complement subspace of column space  $A^\perp$ .

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18      **64. (original)** The apparatus as recited in Claim 57, wherein said  
19 circuitry is configured to determine said at least one signal by using a vector:  
20  $w = (I - P_S)w$  where  $P_S = A^\perp (A^T A^\perp)^{-1} A^T$ , and in scattering channel  
21  $P_S = H^\perp (H^T H^\perp)^{-1} H^T$ .

1           **65. (original)** The apparatus as recited in Claim 57, wherein said  
2 circuitry is configured to determine said at least one signal by using a  
3 null-widening technique that is configured to produce at least one null at a vicinity  
4 of selected angles.

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6           **66. (original)** The apparatus as recited in Claim 57, wherein said  
7 circuitry is configured to determine said at least one signal by selectively  
8 modifying a steering matrix to:

9            $A = [\tilde{a}(\theta_1) \quad \tilde{a}(\theta_2) \quad \dots \quad \tilde{a}(\theta_k)]$

10           wherein  $\tilde{a}(\theta_k) = [a(\theta_k - \Delta\theta_i) \quad a(\theta_k) \quad a(\theta_k + \Delta\theta_i)]$ .

11  
12           **67. (original)** The apparatus as recited in Claim 57, wherein said  
13 circuitry is configured to determine said at least one signal by establishing at least  
14 two nulls such that a rank of  $A$  is less than  $N$ .

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16           **68. (original)** The apparatus as recited in Claim 57, wherein said  
17 circuitry is configured to determine said at least one signal by using adaptive  
18 control of a complementary beam level.

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20           **69. (original)** The apparatus as recited in Claim 57, wherein said  
21 circuitry is configured to determine said at least one signal by, in a non-zero  
22 angular channel, selectively reducing a complementary beam level.

1           70. (original) The apparatus as recited in Claim 57, wherein said  
2 circuitry is configured to determine said at least one signal by, for delay spread  
3 channels, selectively reducing a complementary beam level.

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5           71. (original) The apparatus as recited in Claim 57, wherein said  
6 circuitry is configured to determine said at least one signal by, in free space,  
7 selectively increasing the complementary beam level.

8  
9           72. (original) The apparatus as recited in Claim 41, wherein said  
10 circuitry employs a zero-forcing beamformer to output said at least one signal.

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12          73. (original) The apparatus as recited in Claim 41, wherein said  
13 circuitry employs a maximum SINR beamformer to output said at least one signal.

1       **74. (currently amended)**     The apparatus as recited in Claim 41,  
 2     wherein An apparatus for use in a wireless communication system, the apparatus  
 3     comprising:

4           circuitry configured to output at least one signal suitable for causing a smart  
 5     antenna to transmit at least one complementary beam, said circuitry is being  
 6     configured to construct a plurality of matrices  $Z_1, Z_2, \dots, Z_L$ , where  $L$  is a length of  
 7     a downlink transmission period, such that said plurality of matrices satisfy at least  
 8     one property selected from a group of properties comprising:

9           (a)    for all  $1 \leq i \leq L$ , a matrix  $Z_i$  is a  $k \times m$  matrix whose rows are in a set  
 10           $\{0, \pm U_0^H, \pm U_1^H, \dots, \pm U_{m-k-1}^H\}$ ;

11          (b)    if  $L$  is even, then,  $Z_2 = -Z_1, Z_4 = -Z_3, \dots, Z_L = -Z_{L-1}$ ;

12          (c)    if  $L$  is odd, then  $Z_2 = -Z_1, Z_4 = -Z_3, \dots, Z_{L-1} = -Z_{L-2}, Z_L = 0$ ; and

13          (d)    each element  $+U_0^H, -U_0^H, +U_1^H, -U_1^H, \dots, +U_{m-k-1}^H, -U_{m-k-1}^H$  appear  $p$

14     times in a list of  $Lk$  rows of  $Z_1, Z_2, \dots, Z_L$  for some positive integer  $p$ .

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16       **75. (original)**     The apparatus as recited in Claim 74, wherein rows of  
 17      $Z_{2i-1}$  are, respectively,  $U_{0\oplus i}^H, U_{1\oplus i}^H, \dots, U_{k-1\oplus i}^H$  and where  $i\oplus j$  denote  $(i + j)$   
 18     mod  $(m-k)$  for  $i = 1, 2, 3, \dots, [L/2]$  and wherein  $Z_{2i} = -Z_{2i-1}$ .

19

20       **76. (currently amended)**     The apparatus as recited in Claim 74 34,  
 21     wherein said circuitry is configured to construct a beamforming  
 22     matrix:

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$$S' = \left[ (A^H A)^{-1} A^H / \sqrt{\text{Tr}((A^H A)^{-1})} + \frac{1}{\sqrt{k}} \varepsilon Z_i \right]$$

24     where  $\varepsilon \geq 0$  is a fixed positive number.

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2      77. (original) The apparatus as recited in Claim 76, wherein said  
3 complementary beam is configured to cause a loss of at most  $10 \log_{10}(1+|\varepsilon|^2)$  in a  
4 received signal for an intended recipient.

5  
6      78. (original) The apparatus as recited in Claim 76, wherein said  
7 complementary beam is configured to direct a portion:

$$|\varepsilon|^2 \frac{\sum_{j=1}^m |b_j|^2}{m}$$

8  
9      10 of a resulting transmitted power to another recipient whose spatial signature  
11 is  $B = (b_1, b_2, \dots, b_m)$ .

12  
13      79. (original) The apparatus as recited in Claim 41, wherein said  
14 circuitry is configured to output said signal based on at least a complementary  
15 beamforming matrix at time  $t$  given by:

$$16 \quad S' = \left[ (A^H A)^{-1} A^H / \sqrt{\text{Tr}((A^H A)^{-1})} + \frac{1}{\sqrt{k}} \varepsilon Z_t \right].$$

17  
18      19      80. (original) The apparatus as recited in Claim 41, wherein said  
20 circuitry is configured to output said signal based on at least matrices  $P_0, P_1, \dots, P_{m-k}$   
21 having rows, respectively,  $U_0^H, U_1^H, \dots, U_{m-k}^H$  and wherein a fixed beamforming  
22 matrix that is used is given by:

$$23 \quad S = \left[ (A^H A)^{-1} A^H / \sqrt{\text{Tr}((A^H A)^{-1})} + \frac{1}{\sqrt{k}} \varepsilon \sum_{i=1}^{m-k} P_i \right].$$